

Excess burden and the cost of inefficiency in public services provision^{*}

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Abstract

In this paper we revisit the literature on the economic consequences from inefficiency in public services provision. Following Dupuit (1844) and Pigou (1947) we argue that it is important to take the financing side explicitly into account. The fact that public expenditure financing must rely on distortional taxation implies that both direct and indirect costs are relevant when estimating the economic impacts of inefficiency in public services provision. Using Hicks' compensating variation (following Diamond and McFadden (1974) and Auerbach (1985)) we show that these magnification mechanisms are not only conceptually relevant, they are also important from a quantitative point of view. Specifically, we rely on a range of estimates of public sector efficiency (from Afonso, Schuknecht and Tanzi (2005, 2006)) to illustrate numerically that the relative importance of indirect costs of public sector provision inefficiency, linked to financing through distortional taxation increases with the magnitude of the inefficiency.

Keywords: Government efficiency, excess burden, taxes, spending.

JEL Classification Numbers: D11, E62, H21, H50.

Non-technical summary

In recent years there has been much research focusing on effectiveness and efficiency of public sector activities (see Afonso, Schuknecht and Tanzi (2005) for a brief overview and references). Results suggest that there is ample scope to reduce public spending. However, the literature also stresses that for significant efficiency gains to materialize it is necessary to enact deep changes in public sector management and to transfer activities to the private sector.

The size of government, as measured by the spending-to-GDP ratio, is significantly higher in the euro area or in the European Union than in the US or Japan. Since public expenditure must be financed, taxation is also considerably higher in Europe. Prescott (2004) has recently emphasized that an important reason for lower levels of GDP per capita in Europe when compared with the US, is lower average hours worked, and not productivity differentials. France, for example, has higher output per hour than the US. Again according to Prescott the main determinant of relative labour supplies is differences in tax burdens. Changes in taxation also account for changes in labour supply over time. Thus, it is clear that the financing of public sector activities has allocation effects, over and above those related to the level and composition of public expenditures.

In Public Economics the importance of the financing side of the budget has long been recognized. The French engineer Jules Dupuit as early as in 1844 made the classical contribution (see Dupuit (1844)). A century later, Arthur Pigou (1947), in his classical textbook on Public Finance, emphasized that, when evaluating the cost of public goods to the households' sector, it is crucial to take into account the indirect cost associated with the excess burden of taxation.

When governments raise additional revenue, implied by inefficiency in public services' provision, the required increase in tax rates is more than proportional. In addition, the excess burden increases with the square of the tax rate. The accumulation of these two effects amplifies the impact of inefficiencies in public services' provision, on the economy. Using Hicks' compensating variation (following Diamond and McFadden (1974) and Auerbach (1985)) we show that these

magnification mechanisms are not only conceptually relevant, they are also important from a quantitative point of view.

In this paper we present available empirical evidence on public sector efficiency and we discuss the implications from Dupuit's and Pigou's intuition for the evaluation of the costs associated with inefficiency in public services provision. The analysis concentrates exclusively on the financing side. The provision of public goods is taken as fixed. Increased inefficiency translates into higher taxes. Following Pigou, we argue that a true measure of the cost must take into account the "direct and the indirect damage". We also argue that for reasonable parameter values and given available estimates on public sector efficiency the "indirect damage" is likely significant. Such indirect damage is the higher the greater the provision of public services and the lesser the efficiency in their provision, as illustrated numerically using a simple parameterised example.

Specifically, we rely on a range of estimates of public sector efficiency, for Portugal (from Afonso, Schuknecht and Tanzi, 2005, 2006) to illustrate numerically that the relative importance indirect costs of public sector provision inefficiency, linked to financing through distortionary taxation increases with the magnitude of the inefficiency. Given our parameters, for a situation where tax revenues (including social security contributions) are around 37 per cent of GDP and almost 60 per cent of private consumption, and a use of roughly 27 per cent more resources than the minimum required, taking into account indirect costs of inefficiency increases the estimated magnitude of the loss due to distortionary taxation by about 20 per cent. Our results should be interpreted with care and should not be taken to be in any way accurate. Nevertheless, they illustrate the potential magnitude of the relevant effects. Thus, we conclude that taking direct and indirect costs into account is crucial for the application of rational choice principles and practices to public sector management.

1. Introduction

In recent years there has been much research focusing on effectiveness and efficiency of public sector activities (see Afonso, Schuknecht and Tanzi (2005) for a brief overview and references). Results suggest that there is ample scope to reduce public spending. However, the literature also stresses that for significant efficiency gains to materialize it is necessary to enact deep changes in public sector management and to transfer activities to the private sector.

The interest is justified, namely, by the sharp secular increase in the relative importance of public spending as a percentage in GDP. In the late XIX century, in industrialized countries, the average share of government spending, as a percentage of GDP, was little above 10 per cent. One hundred years later it was about 45 per cent (see Tanzi and Schuknecht (2000) for a survey of the literature and for bibliography).

Growth in the size of government raises key issues of governance and accountability. The Public Choice School forcefully stresses that there was no empirical basis for assuming that governments would always and everywhere operate in a benevolent way. Instead, public choice argues that public sector officials, like all economic agents, respond to incentives associated with the environment they operate in.

The size of government, as measured by the spending-to-GDP ratio, is significantly higher in the euro area or in the European Union than in the US or Japan. Since public expenditure must be financed, taxation is also considerably higher in Europe. Prescott (2004) has recently emphasized that an important reason for lower levels of GDP per capita in Europe when compared with the US, is lower average hours worked, and not productivity differentials. France, for example, has higher output per hour than the US. Again according to Prescott the main determinant for relative labour supplies is differences in tax burdens. Changes in taxation also account for changes in labour supply over time. Therefore, it is clear that the financing of public sector activities has allocation effects, over and above those related to the level and composition of public expenditures. Thus, it is clear that it is crucial to consider financing costs when evaluating the economic impact of public expenditures.

In Public Economics the importance of the financing side of the budget has long been recognized. The French engineer Jules Dupuit as early as in 1844 made the classical contribution (see Dupuit (1844)). A century later, Arthur Pigou (1947), in his classical textbook on Public Finance, emphasized that, when evaluating the cost of public goods to the households' sector, it is crucial to take into account the indirect cost associated with the excess burden of taxation:

“Where there is indirect damage, it ought to be added to the direct loss of satisfaction involved in the withdrawal of the marginal unit of resources by taxation, before this is balanced against the satisfaction yielded by the marginal expenditure. It follows that, in general, expenditure ought not be carried so far as to make the real yield of the last unit of resources expended by the government equal to the real yield of the last unit in the hands of the representative citizen.”

As stated above, for the purpose of our paper the necessary ingredients were already present in Dupuit (1844) as “some of the general properties of taxes which it is well to bear in mind in questions concerning public undertakings, since the latter always and necessarily give rise to a tax or a toll.”(page 276). These general properties of taxes are: *“The heavier the tax, the less it yields relatively. The loss of utility increases with the square of the tax.”* (page 281).

The first of the two propositions refers to the Dupuit-Laffer curve. Dupuit's account of it deserves quotation in full:

“If a tax is gradually increased from zero up to the point where it becomes prohibitive, its yield is at first nil, then increases by small stages until it reaches a maximum, after which it gradually declines until it becomes zero again. It follows that when the state requires to raise a given sum by means of taxation, there are always two rates of tax which fulfil the requirement, one above and one below that which would yield the maximum. There may be a very great difference between the amounts of utility lost through these taxes which yield the same revenue.”(page 278)

In our context, the first proposition means that when government requires additional financing required by inefficiency in public services' provision the implied increase in tax rates is more than proportional to the required addition to tax revenue (even on the upward sloping segment of the Dupuit-Laffer curve, the relation between tax rates and tax revenue is concave). The second proposition simply states that the excess burden

increases with the square of the tax rate. Both effects amplify the impact of inefficiencies in public services' provision on the economy.

The paper has a very limited scope. In modern societies the presence of government in economic life is pervasive. Institutions, laws, administrative procedures and enforcement practices are key in shaping opportunities and incentives open to the private sector. Arguably, through all these channels, inefficiency in public services may have far-reaching consequences throughout the economy. Clearly they are one important determinant of the costs of doing business in a particular location. Most of these are outside the scope of our paper as we concentrate on costs associated with the financing through taxation.

The remainder of the paper is organized as follows. Section two reviews some stylised fiscal facts for the EU, both in terms of spending and tax items. Section three presents available empirical evidence on public sector efficiency. Section four discusses the implications from Dupuit's and Pigou's intuition for the evaluation of the costs associated with inefficiency in public services provision. The analysis concentrates exclusively on the financing side. The provision of public goods is taken as fixed. Increased inefficiency translates into higher taxes. Following Pigou, we will argue that a true measure of the cost must take into account the "direct and the indirect damage". This section then argues that for reasonable parameter values and given available estimates on public sector efficiency the "indirect damage" is likely significant. Such indirect damage is the higher the greater the provision of public services and the lesser the efficiency in their provision, as illustrated numerically. Section five concludes.

2. Some stylised facts of government spending and revenue

In this section we review some trends regarding total general government spending and tax revenues in the European Union, in the last four decades. This overview helps to illustrate notably how significant the share of government spending, as a percentage of GDP, has been during that period.

2.1. General government spending in the EU

Over the past three decades public spending has been on an upward trend in the EU15 countries with a significant increase in the expenditures-to-GDP ratio from 1970 until the beginning of the 1990s, from 35.8 per cent of GDP in 1970 to 51.3 per cent of GDP in 1995. Expenditure-to-GDP ratios then first decreased to 46.8 per cent in 2000 but increased again to 48.0 per cent in 2004. For instance, the share of expenditures in GDP for individual countries increased from 32.6, 37.1 and 42.1 per cent respectively in Italy, France and Sweden in 1970, to 53.8, 49.7 and 58.5 per cent in 1990 (see Table 1).

Table 1 – Total public expenditure as a % of GDP
(General government)

	1970	1980	1985	1990	1995	2000	2004	pp change 2004-1970
AU	37.9	47.2	50.2	49.6	57.2	52.3	50.7	12.8
BE	40.8	56.1	59.3	52.9	52.8	49.2	49.5	8.7
DK	40.8	53.1	56.3	56.1	60.3	54.1	55.0	14.1
FI	29.9	38.7	44.3	46.0	59.6	49.1	50.4	20.5
FR	37.1	45.4	52.0	49.7	55.2	52.5	54.5	17.4
GE	37.7	47.1	46.0	44.1	49.6	48.2	47.5	9.8
GR	24.2	29.0	41.9	48.4	51.0	52.0	50.0	25.8
IR	34.2	46.1	49.0	38.0	41.5	32.0	34.3	0.1
IT	32.6	43.0	51.5	53.8	53.4	48.0	48.4	15.8
LU	28.9	48.4	44.4		45.5	38.5	46.0	17.1
NE	40.1	54.7	56.3	53.0	51.4	46.0	48.0	7.9
PO	19.7	36.1	42.8	38.8	45.0	45.4	46.7	27.0
SP	20.7	31.5	40.4	42.6	45.0	40.0	40.5	19.8
SW	42.1	60.0	62.9	58.5	67.7	57.4	57.0	14.9
UK	36.9	43.2	44.3	39.2	44.5	39.8	43.6	6.6
<i>Min</i>	<i>19.7 (PO)</i>	<i>29.0 (GR)</i>	<i>40.4 (SP)</i>	<i>38.0 (IR)</i>	<i>41.5 (IR)</i>	<i>32.0 (IR)</i>	<i>34.3 (IR)</i>	<i>0.1 (IR)</i>
<i>Max</i>	<i>42.1 (SW)</i>	<i>60.0 (SW)</i>	<i>62.9 (SW)</i>	<i>58.5 (SW)</i>	<i>67.7 (SW)</i>	<i>57.4 (SW)</i>	<i>57.0 (SW)</i>	<i>27.0 (PO)</i>
EU12	35.1	45.0	49.2	48.2	51.6	48.2	48.5	13.4
EU15	35.8	45.4	49.1	47.4	51.3	46.8	48.0	12.2
US	31.7	33.1	35.7	35.5	35.0	32.5	33.8	2.1
JP	18.5	31.2	31.4	31.1	36.9	40.9	38.6	20.1

Source: AMECO Database, updated on 4 April 2005.

Up to 1995 expenditures-to-GDP ratios kept on rising for most countries, reaching more than half of GDP for nine EU countries and going above 60 per cent of GDP for Sweden and Denmark. The aforementioned general trend in public expenditures is reflected in the overall increase of 12.2 percentage points of GDP for the EU15 between 1970 and 2004, which ranged, on a country basis, from a virtual zero

increase in Ireland to a maximum increase of 27 percentage points of GDP in Portugal.

Nevertheless, the limitations imposed by sustainability of public finances led most EU countries to curb down expenditure growth from the mid-1990s onwards. Indeed, the expenditure-to-GDP ratio in the EU15 was reduced from 51.3 per cent in 1995 to 46.8 per cent in 2000, halting therefore the raising trend of public expenditures in the EU.

More particularly, the ratio of public expenditures-to-GDP declined between 1995 and 2000 for all EU countries, with the exception of Greece and Portugal, where that ratio increased by 1.0 and 0.4 percentage points of GDP respectively. Additionally, France and Germany had the lowest decreases of the expenditures-to-GDP ratio between 1995 and 2000, respectively 2.5 and 1.4 percentage points (pp) of GDP while the overall reduction was 3.4 pp of GDP in the EU12 and 4.5 pp of GDP in the EU15. On the other hand only two countries in the EU reported an increase of the respective expenditure-to-GDP ratio between 1995 and 2004: Luxembourg and Portugal (see Table 1).

The increase in total expenditures must be seen against a background where governments gradually tried to focus economic policy towards a better fulfilment of the usually defined “Musgravian” goals: macroeconomic stabilisation, income redistribution, and more efficient resource allocation.¹ In fact, it was during the 1970s and 1980s that most industrialised countries increased the coverage of social programmes such as unemployment insurance. On the other hand, pensions related to public pension programmes, even if introduced in the end of the 19th in Germany, France and Italy were also reinforced in the 1970s and in the 1980s in most European countries. Additionally, population ageing played a major role in pushing up these spending items.

The increase in social transfers in the EU15, during the 1970s and 1980s (some 5 pp of GDP between 1970 and 1990 for the EU15), was generalised to every country. Moreover, for the period 1970-2004 significant increases were recorded in the social

¹ These are the main government functions that were identified by Musgrave (1959). Tanzi and Schuknecht (2000) give a broader view of the determinants of public spending in the last decades.

transfers-to-GDP ratio in Portugal (11.3 pp), Greece (10.2 pp), Finland (8.8 pp), Denmark and Sweden (6.9 pp), and Germany (6.6 pp).

Regarding another important current expenditure category, compensation of employees, its share in GDP increased roughly 1.1 percentage points of GDP for the EU15 countries, between 1970 and 2004. Nevertheless, it is important to mention the existence of large differences both among countries and through time in this expenditure category. For instance, one can notice that the compensation of employees as a share of GDP in 1980 ranged from 9.4 per cent in Greece and Spain to 18.0 and 20.2 per cent in Denmark and Sweden. On the other hand, in 2004 the lower values for those ratios were 7.6, 8.6 and 8.7 per cent respectively in Germany, Luxembourg and Ireland, while the higher reported values were 13.8 per cent in Finland, 14.7 per cent in Portugal, 16.3 per cent in Sweden and 17.8 in Denmark.

In spite of the moderate general increase in the share of compensation of employees in GDP, in the EU15, that ratio did increase more significantly in six countries: Portugal, Denmark, Greece, Spain, Finland, and France. The biggest increases during that period occurred in Portugal, Denmark and Greece, with respectively changes of 7.5, 4.4 and 4.3 percentage points. On the other hand, compensation of employees as a share of GDP decreased between 1970 and 2004 in three countries: Ireland, Germany and Austria, and remained at the same level in the UK.

2.2. General government revenues in the EU

During the last four decades tax revenues as a share of GDP increased in most countries of the EU, as can be seen from Table 2. For instance, this was notably the case of Italy, Spain, Luxembourg, and Portugal, where the aforementioned ratio increased by more than nine percentage points. Small decreases in the tax burdens were observed throughout that period in the UK and in Germany. In 2004 the tax burden ranged from a minimum of 22.1 per cent in Germany to 47.9 per cent in Denmark. Indeed, Denmark alongside with Sweden always depicted tax revenues consistently above 30 per cent of GDP since 1970.

Table 2 – Tax revenues as a % of GDP
(General government)

	1970	1980	1985	1990	1995	2000	2004	pp change 2004-1970
AU	26.8	28.7	30.6	27.1	25.8	27.8	28.0	1.2
BE	23.8	30.1	31.1	28.8	28.9	30.4	30.3	6.5
DK	39.9	43.0	45.5	45.3	47.3	46.9	47.9	8.1
FI	25.8	27.3	30.7	32.6	31.0	35.1	31.7	6.0
FR	21.4	23.0	24.5	23.6	23.8	27.7	26.7	5.3
GE	23.5	25.4	24.6	23.0	22.5	24.6	22.1	-1.4
GR	15.3	15.0	17.1	19.2	21.0	26.0	23.2	7.9
IR	25.0	26.8	29.8	28.7	27.1	26.7	25.7	0.7
IT	15.5	19.0	22.5	25.6	26.9	29.8	28.2	12.7
LU	19.1	28.2	32.5		30.0	29.5	28.9	9.8
NE	23.0	26.8	24.1	26.8	23.1	24.2	24.1	1.2
PO	15.2	17.8	21.4	20.9	22.5	24.8	24.4	9.3
SP	10.7	13.0	17.3	21.9	20.3	22.1	23.1	12.3
SW	31.5	33.8	36.0	38.8	35.6	38.8	36.3	4.7
UK	30.6	29.2	30.5	29.4	28.0	30.3	29.0	-1.6
<i>Min</i>	<i>10.7 (SP)</i>	<i>13.0 (SP)</i>	<i>17.1 (GR)</i>	<i>19.2 (GR)</i>	<i>20.3 (SP)</i>	<i>22.1 (SP)</i>	<i>22.1 (GE)</i>	<i>-1.6 (UK)</i>
<i>Max</i>	<i>39.9 (DK)</i>	<i>43.0 (DK)</i>	<i>45.5 (DK)</i>	<i>45.3 (DK)</i>	<i>47.3 (DK)</i>	<i>46.9 (DK)</i>	<i>47.9 (DK)</i>	<i>12.7 (IT)</i>
EU12					23.9	26.5	25.3	
EU15					25.3	28.0	26.7	
US	22.4	21.2	19.7	20.2	20.7	22.6	18.3	-4.1
JP	15.2	18.1	19.6	21.3	17.5	17.1	15.6	0.4

Source: AMECO Database, updated on 4 April 2005. Total taxes include: current taxes on income and wealth (direct taxes), and taxes linked to imports and production (indirect taxes).

Additionally, it is also possible to notice that the share of direct taxes in GDP for individual countries increased between 1970 and 2004 for all EU countries with the exception of the Netherlands, Germany and Sweden where decreases were reported (see Table 3). In 2004 the direct taxes-to-GDP ratio ranged from 8.9 per cent in Greece to 30.5 per cent in Denmark.

Table 3 – Direct and indirect taxes as a % of GDP
(General government)

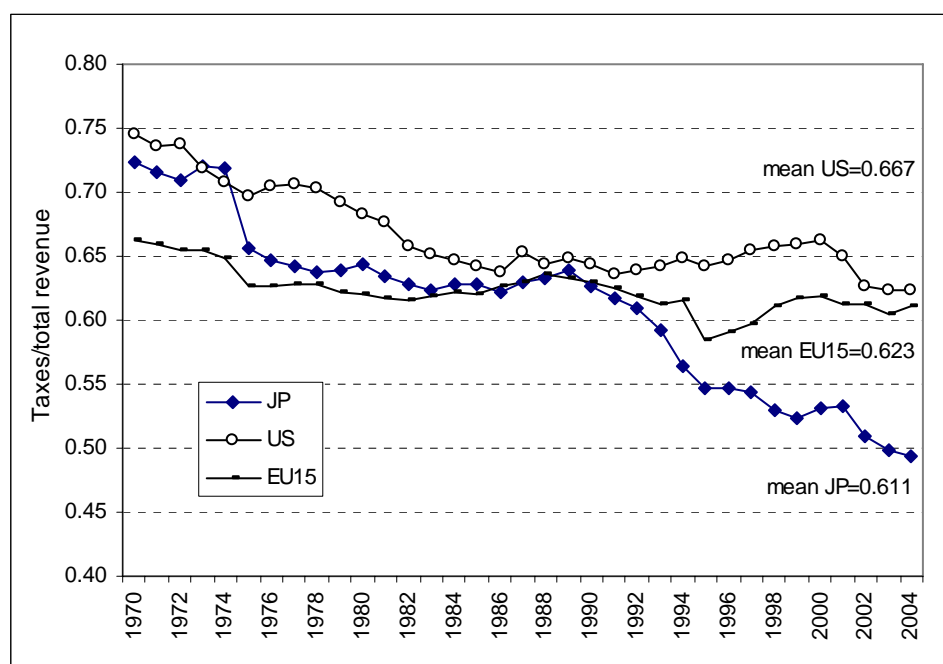
	Current taxes on income and wealth (Direct taxes)				Taxes linked to imports and production (Indirect taxes)			
	1970	2000	2004	pp change 2004-1970	1970	2000	2004	pp change 2004-1970
AU	10.7	13.2	13.1	2.4	16.1	14.6	15.0	-1.2
BE	11.0	17.3	17.1	6.2	12.8	13.1	13.2	0.4
DK	22.0	29.7	30.5	8.5	17.9	17.2	17.5	-0.4
FI	12.9	21.4	17.8	4.9	12.9	13.7	13.9	1.0
FR	6.9	12.2	11.3	4.4	14.6	15.5	15.5	0.9
GE	10.6	12.5	10.2	-0.4	12.9	12.0	11.9	-1.0
GR	3.1	10.8	8.9	5.8	12.2	15.2	14.3	2.1
IR	7.8	13.5	12.5	4.7	17.2	13.2	13.2	-4.0
IT	5.1	14.7	13.7	8.6	10.4	15.0	14.4	4.1
LU	10.6	15.4	13.9	3.4	8.6	14.1	15.0	6.5
NE	12.3	12.1	11.0	-1.3	10.6	12.1	13.1	2.5
PO	5.1	10.4	9.1	4.0	10.1	14.4	15.3	5.3
SP	3.3	10.5	10.7	7.4	7.4	11.7	12.4	4.9
SW	19.5	22.4	19.3	-0.2	12.1	16.4	17.0	4.9
UK	14.4	16.7	15.6	1.2	16.2	13.6	13.4	-2.8
<i>Min</i>	<i>3.1 (GR)</i>	<i>10.4 (PO)</i>	<i>8.9 (GR)</i>	<i>-1.3 (NE)</i>	<i>7.4 (SP)</i>	<i>11.7 (SP)</i>	<i>11.9 (GE)</i>	<i>-4.0 (IR)</i>
<i>Max</i>	<i>22.0 (DK)</i>	<i>29.7 (DK)</i>	<i>30.5 (DK)</i>	<i>8.6 (IT)</i>	<i>17.9 (DK)</i>	<i>17.2 (DK)</i>	<i>17.5 (DK)</i>	<i>6.5 (LU)</i>
EU12		13.0	11.7			13.6	13.6	
EU15		14.3	13.0			13.7	13.7	
US	13.4	8.6	7.3	-0.8	8.9	7.3	7.2	-1.7
JP	8.1	15.4	11.1	-2.3	7.	8.4	8.3	-1.2

Source: AMECO Database, updated on 4 April 2005. Direct taxes – current taxes on income and wealth. Indirect taxes – taxes linked to imports and production.

Moreover, the share of indirect taxes in GDP for individual countries also increased between 1970 and 2003 for most EU countries with the exception of five countries: Austria, Denmark, Germany, Ireland and the UK (see also Table 3). In 2004 the indirect taxes-to-GDP ratio ranged from 11.9% in Germany to 17.5 per cent in Denmark.

Another relevant measure concerns the share of total taxes in total revenues. The developments of such ratio are illustrated in Figure 1 for the EU15 (simple average), Japan and the US. The average share of tax revenues in the general government total revenues in this period, ranged from 0.515 in France and Spain to 0.848 in Denmark. The comparable ratio for the EU15 averaged 0.623 in 2004, encompassing a minimum of 0.584 in 1995 and a maximum of 0.662 in 1970. Those developments in terms of the average EU15 are not very different from the ones observed in the US, while a clearer downward pattern for this ratio is reported for the case of Japan.

Figure 1 – Share of total taxes in total revenues
(General government)



Source: AMECO database, updated on 4 April 2005.

Regarding social security contributions, which are also a major source of financing for general government, Table 4 summarises the relevant developments for the EU15. It is possible to see that throughout the 1970-2004 period social security contributions as a share of GDP increased for all EU15 countries, as well in Japan and in the US.

The development in the social security contributions-to-GDP ratio was not homogeneous for the EU countries in the last years. Indeed, significant rises occurred between 1970-2004 for the cases of Greece, Portugal, and Spain, respectively 8.6, 7.6, and 6.2 pp. On the other hand, more mitigated increases were seen in the cases of the UK, Netherlands, and Luxembourg, while this ratio is quite small in Denmark (where taxes-to-GDP ratios are nevertheless quite above average). If one looks at a more recent period, say between 1995 and 2004, similar patterns emerge regarding the countries where social security contributions share increased, notably Greece, Portugal and Sweden. However, in this case, the main reductions were reported for Finland, France and the Netherlands.

Table 4 – Social security contributions
(General government)

	1970	1980	1985	1990	1995	2000	2004	pp change 2004-1970
AU	10.7	14.6	14.8	15.3	17.3	16.8	16.4	5.7
BE	12.0	14.9	17.1	16.8	16.8	16.1	16.0	4.0
DK	2.4	1.8	2.8	2.3	2.6	3.3	2.7	0.3
FI	5.5	10.9	11.4	12.8	14.8	12.3	12.0	6.4
FR	13.8	19.1	20.8	20.6	20.5	18.2	18.2	4.4
GE	12.3	16.6	17.1	16.5	18.8	18.6	18.2	5.9
GR	7.7	9.4	11.6	11.5	12.6	14.0	16.3	8.6
IR	2.3	4.4	5.1	5.0	6.8	5.7	6.2	3.9
IT	11.2	12.9	13.5	14.3	14.8	12.7	12.9	1.8
LU	8.6	13.4	12.4		12.5	11.2	12.2	3.6
NE	13.1	17.5	19.8	16.4	17.2	17.1	15.1	2.0
PO	5.1	7.9	8.6	10.1	11.0	11.8	12.7	7.6
SP	7.4	12.6	12.7	12.9	13.0	13.3	13.6	6.2
SW	8.6	14.7	13.5	14.9	13.7	15.0	14.7	6.1
UK	5.2	6.0	6.8	6.2	7.5	7.6	8.1	2.9
<i>Min</i>	<i>2.3 (IR)</i>	<i>1.8 (DK)</i>	<i>2.8 (DK)</i>	<i>2.3 (DK)</i>	<i>2.6 (DK)</i>	<i>3.3 (DK)</i>	<i>2.7 (DK)</i>	<i>0.3 (DK)</i>
<i>Max</i>	<i>13.8 (FR)</i>	<i>19.1 (FR)</i>	<i>20.8 (FR)</i>	<i>20.6 (FR)</i>	<i>20.5 (FR)</i>	<i>18.6 (FR)</i>	<i>18.2 (FR)</i>	<i>8.6 (GR)</i>
EU12					17.4	16.2	15.9	
EU15					15.7	14.3	14.3	
US	4.5	6.0	6.7	7.1	7.3	7.2	7.0	2.5
JP	4.3	7.3	8.1	8.9	9.3	9.8	10.9	6.6

Source: AMECO Database, updated on 4 April 2005.

Considering the magnitude of tax revenues, including also social security contributions, the effort supported by the EU15 was 40.9 per cent of GDP in 2004 (see Table 5), which compares with ratios of 25.3 per cent and 26.5 per cent respectively in the US and in Japan. During the period 1970-2004 one can notice significant increases in the share of taxes and social security contributions in GDP for several countries, notably in Spain, Portugal, Greece, and Italy, respectively 18.5, 16.9, 16.4, and 14.5 pp. On the other hand, the smallest increases were recorded for the UK, the Netherlands, Germany and Ireland.

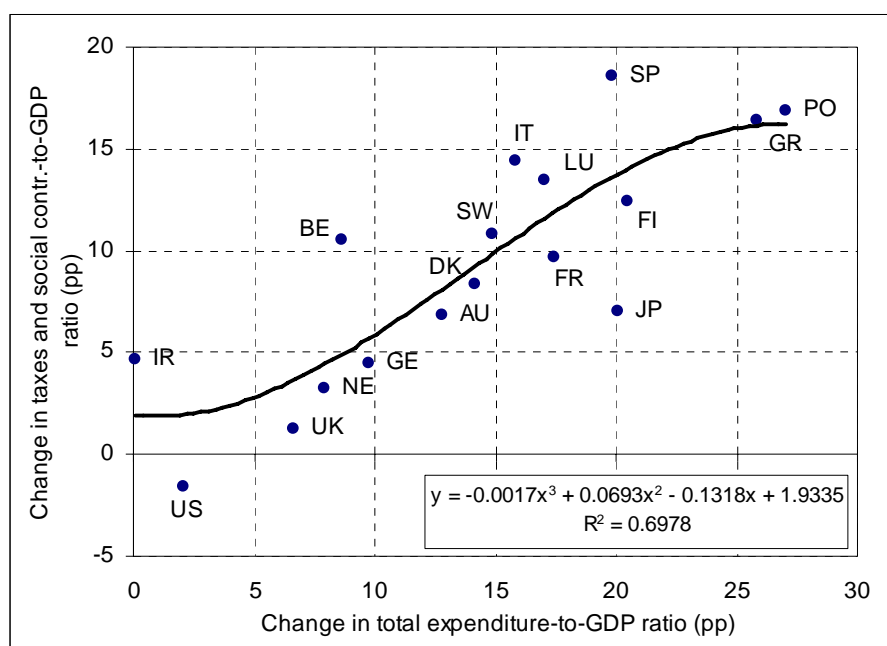
Table 5 – Tax revenues including social security contributions
(General government)

	1970	1980	1985	1990	1995	2000	2004	pp change 2004-1970
AU	37.5	43.3	45.5	42.4	43.1	44.6	44.4	6.9
BE	35.8	45.0	48.2	45.7	45.7	46.5	46.4	10.6
DK	42.3	44.8	48.3	47.6	49.9	50.1	50.7	8.4
FI	31.3	38.2	42.1	45.4	45.8	47.4	43.7	12.4
FR	35.3	42.1	45.3	44.2	44.3	45.8	45.0	9.7
GE	35.9	42.0	41.8	39.4	41.3	43.2	40.3	4.5
GR	23.1	24.4	28.7	30.8	33.5	40.0	39.5	16.4
IR	27.3	31.2	35.0	33.6	34.0	32.4	31.9	4.6
IT	26.6	32.0	36.0	39.9	41.7	42.5	41.1	14.5
LU	27.7	41.6	44.9		42.5	40.7	41.1	13.4
NE	36.0	44.2	44.0	43.2	40.4	41.3	39.3	3.2
PO	20.2	25.7	30.0	31.0	33.4	36.6	37.1	16.9
SP	18.1	25.6	30.0	34.8	33.3	35.4	36.7	18.5
SW	40.2	48.5	49.5	53.7	49.4	53.8	51.0	10.8
UK	35.8	35.3	37.3	35.6	35.5	37.8	37.0	1.3
<i>Min</i>	<i>18.1 (SP)</i>	<i>24.4 (GR)</i>	<i>28.7 (GR)</i>	<i>30.8 (GR)</i>	<i>33.3 (SP)</i>	<i>32.4 (IR)</i>	<i>31.9 (IR)</i>	<i>1.3 (UK)</i>
<i>Max</i>	<i>42.3 (DK)</i>	<i>48.5 (SW)</i>	<i>49.5 (SW)</i>	<i>53.7 (SW)</i>	<i>49.9 (DK)</i>	<i>53.8 (SW)</i>	<i>51.0 (SW)</i>	<i>18.5 (SP)</i>
EU12					41.3	42.7	41.2	
EU15					41.0	42.3	40.9	
US	26.9	27.2	26.4	27.3	27.9	29.8	25.3	-1.6
JP	19.5	25.3	27.7	30.1	26.7	26.9	26.5	7.0

Source: AMECO Database, updated on 4 April 2005.

Additionally, still another relevant stylised fact, which is worthwhile mentioning, is the positive and quite relevant relation that one can visually observe in Figure 2, between the change in the total spending-to-GDP ratio and the change in the taxes and social contributions-to-GDP ratio, in the last four decades. Therefore, this somehow points to the existence of a long-term relationship between total spending and tax revenues, even if we do not want to address here any causality patterns.

Figure 2 – Changes in total spending and in taxes and social contributions-to-GDP ratios, between 1970 and 2004



Source: Tables 1 and 5.

All in all, the stylised evidence reviewed in this section cannot be overlooked as a reinforcement of the conclusion that, as expected, regardless of public spending being carried out either efficiently or inefficiently, the underlying financing relies on taxing the economy. Moreover, the reliance on tax revenues seems to be rather stable throughout the period and across the EU countries, while it is interesting to notice that social security contributions decreased as a ratio to GDP between 1995 and 2004, for the EU as a whole.

3. Inefficiency in the provision of public services

3.1. The theoretical production possibility frontier

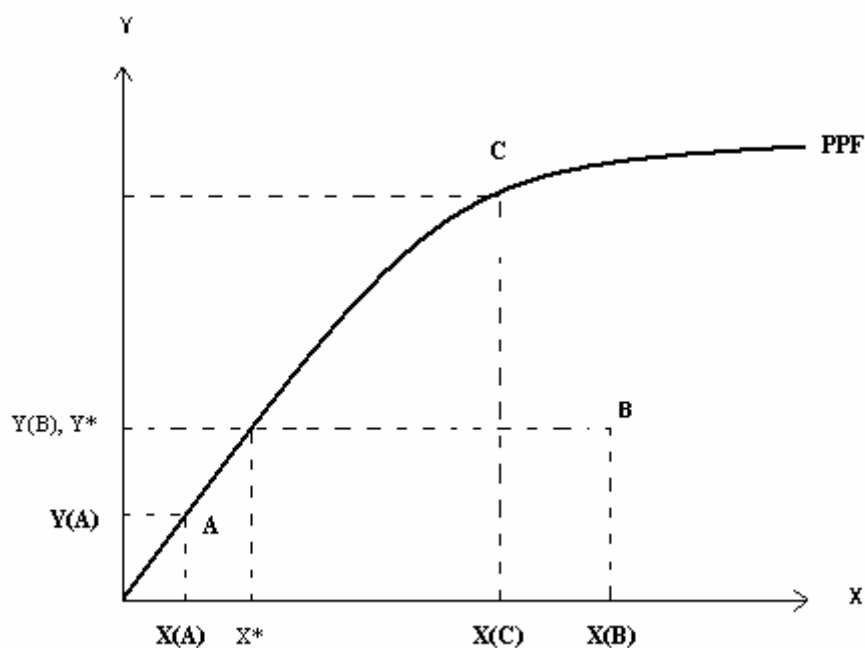
Much has been published recently on efficiency and effectiveness in the provision of public services. The topic is naturally important in many different ways. However, for the purpose of our paper, it suffices to single out a single parameter, measuring efficiency in public services provision. In doing so, we follow Afonso, Schuknecht and Tanzi (2005, 2006). On the basis of cross-country data, for 23 OECD, countries Afonso, Schuknecht and Tanzi (2005) use a non-parametric approach to compute a theoretical production possibility frontier relating public sector performance with

public sector spending. Their efficiency score indicator δ varies from 0 to 1. It is unity for combinations of spending and performance on the production possibility frontier. For combinations inside the frontier the efficiency score indicator is smaller than 1.

Specifically, $\delta < 1$, and from an input orientation perspective, means that the country could provide the same amount of public services with δ per cent of the resources used, if it would move to the efficiency frontier. In other words, assuming that a country could (conceivably) provide a given amount of public sector services on the efficiency frontier, then $\delta < 1$ means that, in actual practice, that country is spending $1/\delta$ times the minimum required. That requires $1/\delta$ times more resources.

Figure 3 displays an example of a production possibility frontier with decreasing returns to scale for the output level Y and cost level X . For instance, countries A and C are efficient, with $\delta = 1$, while a country such as B is inefficient ($\delta < 1$), since it lies inside the frontier. Indeed, country B may be considered inefficient, in the sense that it performs worse than country C, because we have $Y(B) < Y(C)$ and $X(B) > X(C)$. Therefore, country C achieves a better status with less expenditure.

Figure 3 – Production possibility frontier (PPF), variable returns to scale



Still from Figure 3 we can see that (Y^*, X^*) is efficient in the sense that it is impossible to decrease the resources used while maintaining the same output level. On the contrary, $(Y^*, X(B))$ is inefficient since $X(B)/X^* = 1/\delta$, which is above one, that is, displays excess use of resources. Maintaining Y fixed at the level of Y^* it is clear that inefficiency requires the public sector to raise $(1/\delta - 1)X^*$ extra revenues. In other words, $(1/\delta - 1)X^*$ is a measure of the direct cost of inefficiency in the provision of public services, and an actual government spends $1/\delta$ times more than the minimum required. Clearly, $(1/\delta - 1)$ measures, in Pigou's terminology, the direct cost of public sector inefficiency. For example, Afonso, Schuknecht and Tanzi (2005) estimate that, for instance, the input efficiency score δ is 0.79 for Portugal (see next subsection). It means that the country is using 26.6 per cent more resources than the minimum required to provide the current amount of public services.²

The question that naturally follows is: are the direct costs of inefficiency a good measure of the total cost imposed on the economy? Is it a good approximation? In this paper, following the tradition of Dupuit and Pigou, we will investigate whether indirect costs are relevant and by how much relevant.

For the purpose of our discussion we will rely on a powerful simplifying assumption taking the basket of public services as invariant. For example, in Figure 3, we take public services output as fixed at the level Y^* . Thus, we can completely avoid questions about what are the effects of public services on private expenditures, about whether public services are worthwhile and many more. Our analysis focuses exclusively on the financing side. In this paper, we will take into account the budget constraint of the public sector. In other words we will make it explicit that public sector expenditure must be financed by taxation.³

² In Afonso, Schuknecht and Tanzi (2006), using a different sample of countries, the authors report an estimated δ of 0.385, for Portugal. Such estimate implies that the country is using 159 per cent more resources than the minimum necessary to provide the same bundle of public services (see Table 7 below).

³ It is clear that the intertemporal budget constraint implies that present and future public expenditure has to be financed by present or future taxation. In order to keep our analysis simple we abstract from the intertemporal aspects of budgetary policy. Naturally unsustainable budgetary policies would likely exacerbate the costs and distortions associated with the activities of the public sector.

In order to address these questions it is necessary to model the household sector of the economy in some detail. However, a much stylised representation of the production side will suffice. Specifically, we follow the standard set of assumptions in the literature and assume that a single representative household can represent the consumption sector and that the economy's production possibilities can be captured by a linear technology. In particular, we will assume a single production factor, labour, and constant returns to scale. Finally, and most importantly, we will assume that lump sum taxation is not institutionally feasible. Only economic transactions can be taxed. Work and consumption can be taxed while leisure cannot⁴.

We will compare a situation where the public sector has to raise $R^*=X^*$ in taxes with a situation where the public sector is inefficient and must therefore raise $R=X(B)$ in taxes, for the example in Figure 3. Therefore, we know that $(R-R^*)=(1/\delta-1)R^*$.

Now it is clearly true that there are many ways to raise additional resources. So it seems that we cannot make further progress without adding some assumption about the structures of taxation and how it changes in order to obtain extra revenues. One possibility would be to assume that the structure of taxation is optimal. Such assumption is workable but it seems to us, unrealistic. Thus, we assume instead that there is some initial structure of taxation and that the government raises additional revenue simply by changing the tax structure in a proportional way (in section 2.2 we saw from historical data for the EU that this is not too far from reality). Such assumption, we agree, is not only natural but allows us to simplify our problem tremendously. This is so because the restriction we impose on the tax structure, combined with our assumptions about technology, allows us to apply the composite commodity theorem (of Hicks (1936) and Leontief (1936)). As we will show in the next sub-section, under our set of assumptions the financing problem of the government collapses into the choice of a single tax rate.

⁴ These assumptions are discussed in Diamond and Mirrless (1971), Atkinson and Stiglitz (1972) and Atkinson and Stiglitz (1980). Atkinson and Stiglitz (1980) and Auerbach (1985) discuss many important extensions and include complete references to the relevant literature.

3.2. Efficient provision of public services: some evidence

In this section we report on some of the available evidence in the literature regarding public sector efficiency in the provision of public services. From such evidence we can afterwards assess the plausibility of the magnitude of inefficiency to use ahead in the numerical simulations in section five.

In order to compute a composite indicator of public sector performance for OECD countries, Afonso, Schuknecht and Tanzi (2005) use several sub-indicators of public performance that take into account, for instance, administrative, education, health and public infrastructure outcomes. They also look at other indicators to incorporate information on the usually defined “Musgravian” functions of the government: macroeconomic stabilisation, income redistribution and efficient resource allocation. The so-called performance indicators are compiled from various indices that have each an equal weight. Based on that performance indicator as an output measure, they computed efficiency scores, which we reproduce in Table 6.

The average input efficiency of the EU15 countries is 0.72 meaning that they should be able to attain the same level output using only 72 per cent of the inputs they are currently using. In other words, on average, the sample countries are using 38.9 per cent more resources than the minimum required to provide the same amount of public services.

Table 6 – Public sector efficiency scores: 2000

Country	Input efficiency		Output efficiency	
	Score	Rank	Score	Rank
Australia	0.99	4	0.92	7
Austria	0.67	17	0.92	8
Belgium	0.66	19	0.79	18
Canada	0.75	12	0.84	13
Denmark	0.62	21	0.87	11
Finland	0.61	22	0.83	14
France	0.64	20	0.77	20
Germany	0.72	16	0.79	17
Greece	0.73	14	0.65	23
Iceland	0.87	7	0.90	10
Ireland	0.96	5	0.93	6
Italy	0.66	18	0.68	22
Japan	1.00	1	1.00	1
Luxembourg	1.00	1	1.00	1
Netherlands	0.72	15	0.91	9
New Zealand	0.83	9	0.81	15
Norway	0.73	13	0.93	5
Portugal	0.79	11	0.70	21
Spain	0.80	10	0.78	19
Sweden	0.57	23	0.86	12
Switzerland	0.95	6	0.94	4
United Kingdom	0.84	8	0.80	16
United States	1.00	1	1.00	1
EU15 *	0.72		0.78	

Source: adapted from Afonso, Schuknecht and Tanzi (2005), Free Disposable Hull scores.

* - Weighted averages according to the share of each country GDP in the EU15.

The average output efficiency score of the EU15 implies that with given public expenditures, public sector performance is 78 percent (or 22 percent less) of what it could be if the EU15 was on the production possibility frontier (and more if the countries on the production possibility frontier also have scope for expenditure savings).

Afonso, Schuknecht, and Tanzi (2006) provide another set of efficiency calculations, for the new EU member states and for a set of mostly emerging markets. We report such results in Table 7.

Table 7 – Public sector efficiency scores: 2001/2003

Country	Input efficiency		Output efficiency	
	Score	Rank	Score	Rank
Brazil	0.381	22	0.488	22
Bulgaria	0.461	14	0.483	23
Chile	0.730	4	0.615	17
Cyprus	0.489	11	0.867	3
Czech Republic	0.439	15	0.637	13
Estonia	0.489	12	0.632	14
Greece	0.369	23	0.713	8
Hungary	0.355	24	0.687	9
Ireland	0.576	8	0.813	4
Korea	0.749	3	0.743	6
Latvia	0.486	13	0.624	16
Lithuania	0.535	9	0.588	18
Malta	0.408	19	0.753	5
Mauritius	0.721	5	0.686	10
Mexico	0.703	6	0.551	19
Poland	0.412	18	0.627	15
Portugal	0.385	21	0.678	11
Romania	0.528	10	0.509	21
Singapore	1.000	1	1.000	1
Slovak Republic	0.406	20	0.674	12
Slovenia	0.431	16	0.731	7
South Africa	0.676	7	0.529	20
Thailand	1.000	1	1.000	1
Turkey	0.416	17	0.482	24
Average	0.548		0.671	

Source: adapted from Afonso, Schuknecht and Tanzi (2006). Variable returns to scale efficiency scores, via Data Envelopment Analysis.

Interestingly, one can notice, for instance, that countries like Greece and Portugal, which are present in both the results of Table 6 and 7, come out as less efficient in the second subset in terms of input efficiency (even if the underlying variables are not totally comparable). In practice, and due to the fact of differences in relative prices in the provision of public services, notably regarding compensation of employees, what one can guess is that, for such countries, the efficiency scores from Table 6 could be overestimated while the efficiency scores from Table 7 may be underestimated. All in all, and as a tentative assessment, this could provide a possible range for the input efficiency scores for countries present in both samples.

Inspired on the analysis of Afonso, Schuknecht, and Tanzi (2005), additional the Social and Cultural Planning Office (SCP) of the Netherlands (2004) provides also results for public sector performance. This analysis includes 22 countries, and notably

four new members of the EU, Czech Republic, Hungary, Poland and Slovakia, alongside with the EU15. In line with Afonso et al. (2005), they use 19 indicators divided into four main groups: stabilisation/growth, distribution, allocation and quality of public administration.

The results reported by the SCP (2004) seem to point to the fact that there isn't much relation between public performance and public spending. The best performers are Ireland, Finland and Luxembourg. Good performers are also Sweden, Denmark, Austria, and the Netherlands. Most southern European countries, notably Portugal, Greece and Italy, and also Hungary, show below average performance and average public spending. All in all, both set of results point to the existence of relevant inefficiencies in the provision of public services.⁵

In this paper, we will not take a stand on the accuracy and reliability of the available estimates. Instead, we will use the range of input efficiency estimates, for Portugal, from Afonso, Schuknecht and Tanzi (2005, 2006), for the numerical examples of subsection 4.2.

4. The simplest theoretical framework

Here we review some of the theoretical underpinnings. We will explore the costs associated with the financing of inefficiency in public services provision through distortional taxation. We will use Hicks' compensating variation (following Diamond and McFadden (1974) and Auerbach (1985)) to show that these magnification mechanisms are not only conceptually relevant, they are also important from a quantitative point of view. Specifically, we rely on a range of estimates of public sector efficiency (from Afonso, Schuknecht and Tanzi (2005, 2006) to illustrate numerically that the relative importance of indirect costs of public sector provision inefficiency, linked to financing through distortional taxation, increases with the magnitude of the inefficiency.

⁵ Additional cross-country efficiency calculations, for the provision of public services in specific areas of public intervention, can be found in SCP (2004), and in Afonso and St. Aubyn (2005, 2006).

4.1. Direct and indirect costs of inefficiency

Under our assumptions, consumer choices may be summarized (without loss of generality) as involving only two goods (consumption and leisure). In such a setting, without any external source of income, the household budget constraint is

$$(1 + t^c)px = w(1 - t^l)(T - l), \quad (1)$$

where t^c is the tax rate on consumption, p is the producer price of the consumption good (assumed fixed by perfect competition and linear technology), x is consumption, w the gross wage rate, t^l the tax on work, T is the time endowment (given) and, finally, l is leisure.

Thus there is no loss of generality in writing:

$$\frac{1 + t^c}{1 - t^l} px = w(T - l), \quad (2)$$

or simply

$$(1 + t)px = (T - l), \quad (3)$$

where $(1 + t) = (1 + t^c)/(1 - t^l)$ and we take leisure (or work) as the numeraire (that is we take $w = 1$)⁶. Equation (3) may be written in compact form as

$$qx = (T - l), \quad (4)$$

where $q = (1 + t)p$.

Such form is frequently used in the optimal taxation literature where q denotes consumer prices and p denotes producer prices.

⁶ Alternatively equation (3) could be written as: $px = (1 - \tau)(T - l)$ where $\tau = \frac{t}{1 + t}$.

Formulated in these terms our problem becomes very simple and can be approached following the methodology in Diamond and McFadden (1974) and Auerbach (1985). For our specific case it implies the following steps:

First, we take a situation of efficiency in public services' provision as our starting point. In other words we will consider a pair (Y^0, X^0) in the production possibility frontier in Figure 3. The necessary resources X^0 correspond exactly to the tax revenues collected:

$$X^0 = R^0 = t^0 x((1+t^0)p, 0) = t^0 h((1+t^0)p, u^0). \quad (5)$$

It is true that

$$e((1+t^0)p, u^0) = e(q^0, u^0) = 0, \quad (6)$$

where $x(.)$ is the Marshallian demand function; $h(.)$ the Hicksian demand function and $e(.)$ the expenditure function. u^0 denotes the utility that the representative consumer attains when the provision of public services Y^0 is done efficiently. Equation (6) is implied by our simplifying assumption that *all* of the income, obtained by our representative consumer, derives from work effort. In other words, we assume that there is no *lump sum* income, when public services provision is done efficiently.

As we have seen before if provision is inefficient it is necessary to raise additional revenue:

$$R^1 = \frac{R^0}{\delta}. \quad (7)$$

In order to raise R^1 the government – in the model – will have to increase taxes. To ensure consistency with the measures of welfare change that we will propose to use (the Hicksian compensating variation) we must determine the required tax rate, t^1 ,

using the Hicksian demand function. The level of utility to use will be u^0 , exactly the level that the representative consumer will attain under efficient provision.

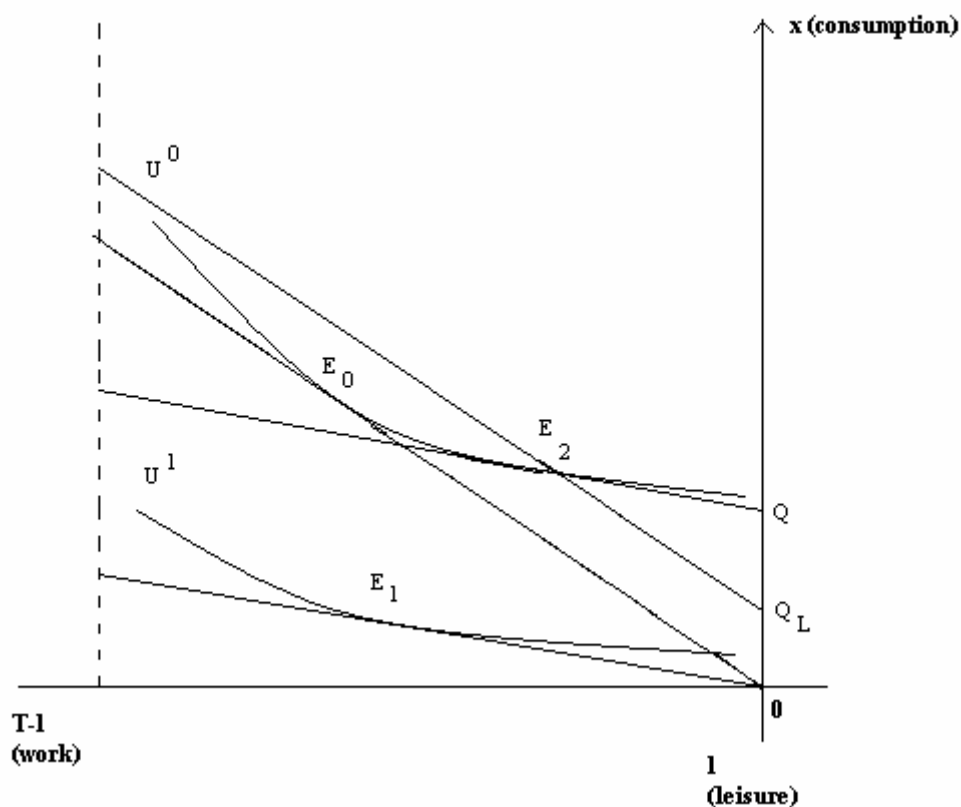
Thus, to wrap up the new required level of taxation will have to satisfy:

$$R^1 = \frac{R^0}{\delta} = R((1+t^1)p, u^0) = t^1 ph((1+t^1)p, u^0), \quad (8)$$

where R is the tax revenue function as in Diamond and McFadden (1974). Hence, the second step, in our procedure, is to determine the tax rate, t^1 that is necessary to balance the budget under the relevant degree of inefficiency in public service provision.

Figure 4 allows a simple graphical explanation of the loss, in consumption terms, for the consumer, associated with inefficiency in public services' provision.

Figure 4 – Consumer's loss due to inefficiency in public services' provision



In Figure 4 our starting point, E_0 , satisfies $e((1+t^0)p, u^0) = 0$ by construction. If one would consider only the increase in taxes from t^0 to t^1 , without compensating the consumer, welfare would decline to u^1 , at point E_1 . Without compensation, expenditure – at the new level of welfare – would remain unchanged: $e((1+t^1)p, u^1) = 0$. When taxation increases, as required by inefficiency in public services' provision, the consumer must be compensated, in order to be able to attain the initial level of utility. When such compensation is paid, the budget constraint shifts up, and the corresponding equilibrium is labelled E_2 in Figure 4. The increase in taxation is thus associated with a total loss (as measured by Hicks' compensating variation), in terms of consumption, of OQ , of which OQ_L is the change in the deadweight loss while Q_LQ is the additional tax revenue.

In other words, in order to quantify (in monetary units) the consumer's welfare we take the level of utility u^0 and ask: how much would it be necessary to pay the consumer so that she would be able to reach the initial level of welfare when taxes are increased from t^0 to t^1 ? The answer is given by the compensating variation, CV :

$$\begin{aligned} CV &= e((1+t^1)p, u^0) - e((1+t^0)p, u^0) = \\ &= e((1+t^1)p, u^0) - e((1+t^1)p, u^1), \end{aligned} \tag{9}$$

where the latter equality makes it clear that the compensating variation measures welfare change, in the monetary units, evaluated at the consumer prices prevailing in the after tax increase situation.

Therefore,

$$L(t^1, t^0, u^0) = CV(t^1, t^0, u^0) - R^0 \left(\frac{1}{\delta} - 1 \right), \tag{10}$$

is our measure of deadweight loss or excess burden. Thus the third and last step in our procedure is to compute the compensating variation and the corresponding measure of excess burden or deadweight loss.

4.2. Costs of inefficiency in public services provision

In order to make our procedure operational, it is necessary to make assumptions about consumer preferences and constraints. In this subsection we provide some estimates of using a simple parameterised example based on the linear expenditure system (Stone-Geary preferences):⁷

$$U = (l - \gamma_0)^{\alpha_0} (x - \gamma_1)^{\alpha_1}. \quad (11)$$

The indirect utility function for the Stone-Geary preferences $v(\cdot)$ is given by

$$v(p(1+t), 1, 0) = \max_{x, l} \left\{ (l - \gamma_0)^{\alpha_0} (x - \gamma_1)^{\alpha_1} : T \geq l \geq \gamma_0 \geq 0; x \geq \gamma_1 \geq 0; (1+t)px = T - l \right\}. \quad (12)$$

By assumption, we have $\alpha_0 + \alpha_1 = 1$. It is easy to show that the Marshallian demand functions corresponding to the solution to the above problem, taking into account the household budget constraint (3), may be written as:⁸

$$l = \gamma_0 + \alpha_0(T - \gamma_0 - p(1+t)\gamma_1), \quad (13)$$

$$x = \gamma_1 + \frac{\alpha_1}{p(1+t)}(T - \gamma_0 - p(1+t)\gamma_1). \quad (14)$$

It is possible to use the Marshallian demand equations to substitute for x and l in the utility function obtaining the indirect utility function defined above. The indirect utility function, in turn may be inverted to obtain the corresponding expenditure function:

$$e(p(1+t), 1, U) = -T + \gamma_0 + p(1+t)\gamma_1 + \frac{p(1+t)^{\alpha_1}}{\alpha_0^{\alpha_0} \alpha_1^{\alpha_1}} U. \quad (15)$$

⁷ See notably Geary (1950-51).

⁸ See Appendix A.

Deriving the expenditure function in order of the consumer price $q=p(1+t)$ allows us to obtain the Hicksian demand for the consumer good:

$$h(p(1+t), 1, U) = \frac{\partial e(p(1+t), 1, u)}{\partial q} = \gamma_1 + \frac{\alpha_1 p(1+t)^{\alpha_1-1}}{\alpha_0^{\alpha_0} \alpha_1^{\alpha_1}} U. \quad (16)$$

In our example when public services' provision is efficient the tax rate is t^0 . Since we will take that situation as our reference situation we will start out with: $e(p(1+t^0), 1, U^0) = 0$.

We use this condition to determine the reference utility level, U^0 in (15). Using this same utility level in (16) we obtain the Hicksian or compensated demand function corresponding to the financing needs of the public sector under efficiency in the provision of public services.

We are now ready to follow the procedure described in section 2. The parameters used in the simulation will be either inspired by some facts about the Portuguese economy or will be chosen arbitrarily (we will be explicit about all relevant assumptions made).

For instance, in Portugal, in 2004, tax revenues (including social security contributions) were 37.1 per cent of GDP (see Table 5) or almost 60 per cent of private consumption. In Afonso, Schuknecht and Tanzi, (2005, 2006), efficiency in public service provision, in Portugal, is estimated at, respectively, 0.79 and 0.39. We use this range to argue that it makes sense to assume that if public service provision were efficient in Portugal, taxation in the range of 37.5 per cent of consumption would suffice for its financing. Assuming $T=168=7 \times 24$ (just a normalization of the time endowment), $\alpha_0 = \alpha_1 = 1/2$, $\gamma_0 = 98$ and $\gamma_1 = 5$. Thus, given the conventions adopted, efficient provision of the given amount of public services requires 14.625 monetary units. Hence, t^0 must equal 0.6 ($\tau=37.5$ per cent).

Let us now quantify what happens when the efficiency in public services' provision deteriorate to the levels estimated by Afonso et al. (2005) for the Portuguese case.

Their estimate of efficiency delivers $\delta=0.79$, which implies that to maintain the level of provision an increase of $(1/0.79)-1=26.6$ per cent is required. If we use the alternative estimate in Afonso et al. (2006), given that $\delta=0.39$ the increase required is $(1/0.39)-1=156.4$ per cent.

Using the Hicksian or compensated demand curve for consumption it is easy to see that the tax revenue function implies that the tax rate must increase to approximately $t^I=0.795$, in the first case ($\tau=44.3$ per cent). Given that the Hicksian demand function is downward slopping the increase in the tax rate required is proportionally greater than the required increase in tax revenue. Such effect corresponds to the curvature of the Dupuit-Laffer curve. The effect is evidently more pronounced for the higher estimate of inefficiency. In this case $t^I=1.945$ ($\tau=66.0$ per cent).

Using the new tax rate in the expenditure function we may now see that the total loss (direct and indirect) borne by the consumer is 4.64 monetary units. The value of the loss compares with an increase in tax revenue of 3.89. Given our parameters, taking into account indirect costs of inefficiency increases the estimated magnitude of the loss by about 20 per cent. In our second case the total loss to the consumer equals a much larger 28.8 monetary units, which compares with an increase in tax revenue of 22.9. The indirect costs, associated with the excess burden, are now 26 per cent. Table 8 reports the results for alternative values of efficiency in public services provision.

Table 8 – Numerical simulation for alternative efficiency scores
($t^0=0.6$; $\tau=37.5\%$; $\alpha_0=\alpha_I=0.5$; $\gamma_I=5$)

Efficiency score (δ)	t^I	τ (%)	Total loss (monetary units)	Variation in tax revenues (monetary units)	Increase in the estimated magnitude of loss (%)
1.00	0.600	37.5	0.00	0.00	-
0.79	0.795	44.3	4.64	3.89	19.3
0.70	0.921	47.9	7.54	6.27	20.3
0.65	1.009	50.2	9.53	7.88	21.0
0.60	1.116	52.7	11.87	9.75	21.8
0.55	1.245	55.5	14.67	11.97	22.6
0.50	1.406	58.4	18.07	14.63	23.5
0.45	1.612	61.7	22.27	17.88	24.6
0.39	1.945	66.0	28.84	22.88	26.1

From Table 8 we can clearly discern the importance of Dupuit-Pigou effects. In fact, we may verify Dupuit's two general principles of taxation at work: first, the revenue shortfall associated with inefficiency in the provision of public services demands a more than proportional increase in tax rates. In Dupuit's words "*The heavier the tax, the less it yields relatively.*" Second, the total loss increases significantly faster than the tax rate ("*The loss of utility increases with the square of the tax.*")

In our example the magnification of the cost of inefficiency in public sector provision is always significant and its relative importance increases with the magnitude the inefficiency. Specifically, as the efficiency coefficient declines from 0.79 to 0.39, the relative importance of indirect costs on total costs increases from 19.3 to 26.1 per cent. In general, as the provision of public services and the degree of inefficiency increase the more important it becomes to take the indirect costs of provision, through distortional taxation, into account.

In order to assess the sensitivity of our numerical simulations, we report in Table 9 an alternative case, where the consumer has a higher preference for leisure, with $\alpha_0=0.6$.

Table 9 – Numerical simulation for alternative efficiency scores
($t^0=0.6$; $\tau=37.5\%$; $\alpha_0=0.6$; $\alpha_I=0.4$; $\gamma_I=5$)

Efficiency score (δ)	t^I	τ (%)	Total loss (monetary units)	Variation in tax revenues (monetary units)	Increase in the estimated magnitude of loss (%)
1.00	0.600	37.5	0.00	0.00	-
0.79	0.801	44.5	4.01	3.27	22.7
0.70	0.933	48.3	6.53	5.27	23.9
0.65	1.025	50.6	8.26	6.62	24.7
0.60	1.137	53.2	10.29	8.20	25.5
0.55	1.274	56.0	12.73	10.06	26.5
0.50	1.446	59.1	15.70	12.30	27.6
0.45	1.666	62.5	19.37	15.03	28.8
0.39	2.025	66.9	25.11	19.24	30.5

Under such conditions, the indirect costs, associated with the excess burden, are now higher and, for instance, for the case of the lowest efficiency coefficient of 0.39, are almost 31 per cent.

We report in Table 10 the results for the baseline case using instead $\gamma_I=0$, which imposes in this case both a higher tax burden and higher associated costs (see also Appendix B for additional alternative values attributed to the different parameters, both with the Stone-Geary function and with a Cobb-Douglas function).

Table 10 – Numerical simulation for alternative efficiency scores
($t^0=0.6$; $\tau=37.5\%$; $\alpha_0=\alpha_I=0.5$; $\gamma_I=0$)

Efficiency score (δ)	t^I	τ (%)	Total loss (monetary units)	Variation in tax revenues (monetary units)	Increase in the estimated magnitude of loss (%)
1.00	0.600	37.5	0.00	0.00	-
0.79	0.807	44.7	4.39	3.49	25.9
0.70	0.945	48.6	7.18	5.63	27.6
0.65	1.043	51.1	9.10	7.07	28.8
0.60	1.163	53.8	11.38	8.75	30.1
0.55	1.311	56.7	14.13	10.74	31.6
0.50	1.500	60.0	17.50	13.13	33.3
0.45	1.747	63.6	21.72	16.04	35.4
0.39	2.163	68.4	28.42	20.53	38.5

5. Conclusion

In the last four decades there has been a considerable increase in the share of public expenditures in GDP. It prolongs the trend that goes back at least to the late nineteenth century (see Tanzi and Schuknecht, 2000). Such pattern has been accompanied by a substantial increase in public sector revenues, especially derived from taxation and contributions to social security. The stylised evidence reviewed documents these dynamics with a special focus on EU countries.

In this paper revisit the literature on the economic consequences from inefficiency in public services provision. The literature finds that, in many countries, inefficiency in public services' provision is considerable. Most authors emphasize the need of changing public sector management practices and the scope of activities carried out by general government. Following Dupuit (1844) and Pigou (1947) we focus instead on the financing side.

The fact that public sector financing must rely on distortional taxation implies that it is important to take into account the direct and indirect costs implied by inefficiency

in public services provision. Financing spending through distortionary taxation leads to a magnification of overall costs due to the operation of two general propositions about taxation, already identified by Dupuit (1844). The first states that it is, in general, necessary to increase tax rates more than proportionally to the additional revenue needed due to inefficiency. The second states that the excess burden or deadweight loss associated with taxation increases with the square of the tax rate. Using simple numerical examples, using Hicks' compensating variation (following Diamond and McFadden (1974) and Auerbach (1985)), and some public sector inefficiency coefficients from the existing literature, we show that these magnification mechanisms are not only conceptually relevant, they are also important from a quantitative point of view.

Specifically, we rely on a range of estimates of public sector efficiency, for Portugal (from Afonso, Schuknecht and Tanzi, 2005, 2006) to illustrate numerically that the relative importance indirect costs of public sector provision inefficiency, linked to financing through distortionary taxation increases with the magnitude of the inefficiency. Given our parameters, for a situation where tax revenues (including social security contributions) are around 37 per cent of GDP and almost 60 per cent of private consumption, and a use of roughly 27 per cent more resources than the minimum required, taking into account indirect costs of inefficiency increases the estimated magnitude of the loss due to distortionary taxation by about 20 per cent. These results should be interpreted with care and should not be taken to be in any way accurate. Nevertheless, they illustrate the potential magnitude of the relevant effects.

Thus, we conclude that taking direct and indirect costs into account is crucial for the application of rational choice principles and practices to public sector management.

Appendix A – Demand functions

Using the Stone-Geary utility function and the household budget constraint, we can write the consumer's maximization problem

$$\begin{cases} \text{Max } U = (l - \gamma_0)^{\alpha_0} (x - \gamma_1)^{\alpha_1} \\ \text{s. to } (1+t)px = T - l \end{cases}, \quad (\text{A1})$$

and the corresponding Lagrange function,

$$Z = (l - \gamma_0)^{\alpha_0} (x - \gamma_1)^{\alpha_1} + \lambda[(1+t)px - T + l]. \quad (\text{A2})$$

After setting the first partial derivatives to zero,

$$\partial Z / \partial l = \alpha_0 (l - \gamma_0)^{\alpha_0-1} (x - \gamma_1)^{\alpha_1} + \lambda = 0 \quad (\text{A3})$$

$$\partial Z / \partial x = \alpha_1 (l - \gamma_0)^{\alpha_0} (x - \gamma_1)^{\alpha_1-1} + \lambda(1+t)p = 0 \quad (\text{A4})$$

$$\partial Z / \partial \lambda = (1+t)px - T + l = 0, \quad (\text{A5})$$

we can multiply both sides of (A3) by $(l - \gamma_0)$, and simplify:

$$\alpha_0 U + \lambda(l - \gamma_0) = 0 \quad (\text{A6})$$

$$l = \gamma_0 - \frac{\alpha_0 U}{\lambda}. \quad (\text{A7})$$

Similarly, multiply both sides of (A4) by $(x - \gamma_1)$,

$$\alpha_1 U + \lambda(1+t)p(x - \gamma_1) = 0 \quad (\text{A8})$$

$$x = \gamma_1 - \frac{\alpha_1 U}{\lambda(1+t)p}. \quad (\text{A9})$$

Substituting (A7) and (A9) in (A5)

$$(1+t)p\left[\gamma_1 - \frac{\alpha_1 U}{\lambda(1+t)p}\right] - T + \left[\gamma_0 - \frac{\alpha_0 U}{\lambda}\right] = 0, \quad (\text{A10})$$

and multiplying (A10) by λ ,

$$[(1+t)p\gamma_1 - T + \gamma_0]\lambda = (\alpha_1 + \alpha_0)U \quad (\text{A11})$$

$$\lambda = U / [p(1+t)\gamma_1 - T + \gamma_0]. \quad (\text{A12})$$

Finally, substituting (A12) back in (A7) and (A9) gives us the Marshallian demand functions reported in section 4.2 of the text:

$$l = \gamma_0 + \alpha_0(T - \gamma_0 - p(1+t)\gamma_1) \quad (\text{A13})$$

$$x = \gamma_1 + \frac{\alpha_1}{p(1+t)}(T - \gamma_0 - p(1+t)\gamma_1). \quad (\text{A14})$$

To obtain the indirect utility function substitute the demand equations (A13) and (A14) in the ordinary utility function,

$$U = [\gamma_0 + \alpha_0(T - \gamma_0 - p(1+t)\gamma_1) - \gamma_0]^{\alpha_0} \left[\gamma_1 + \frac{\alpha_1}{p(1+t)}(T - \gamma_0 - p(1+t)\gamma_1) - \gamma_1 \right]^{\alpha_1} \quad (\text{A15})$$

$$U = \frac{\alpha_0^{\alpha_0} \alpha_1^{\alpha_1}}{p(1+t)^{\alpha_1}} (T - \gamma_0 - p(1+t)\gamma_1). \quad (\text{A16})$$

Inverting (A16), we can write the expenditure function $e(p(1+t), l, U)$ as

$$e(p(1+t), l, U) = -T + \gamma_0 + p(1+t)\gamma_1 + \frac{p(1+t)^{\alpha_1}}{\alpha_0^{\alpha_0} \alpha_1^{\alpha_1}} U \quad (\text{A17})$$

our equation (15) in the text. At last, the Hicksian demand is obtained by computing the partial derivative of (A17) with respect to the consumer price $q=p(1+t)$:

$$\frac{\partial e}{\partial q} = \gamma_1 + \frac{\alpha_1 p(1+t)^{\alpha_1-1}}{\alpha_0^{\alpha_0} \alpha_1^{\alpha_1}} U. \quad (\text{A18})$$

Appendix B – Alternative simulations

- With the Stone-Geary utility function:

Table A1 – Numerical simulation for alternative efficiency scores
($t^0=0.6$; $\tau=37.5\%$; $\alpha_0=0.7$; $\alpha_I=0.3$; $\gamma_I=5$)

Efficiency score (δ)	t^I	τ (%)	Total loss (monetary units)	Variation in tax revenues (monetary units)	Increase in the estimated magnitude of loss (%)
1.00	0.600	37.5	0.00	0.00	-
0.79	0.805	44.6	3.31	2.65	24.8
0.70	0.940	48.5	5.39	4.28	26.1
0.65	1.035	50.9	6.82	5.37	26.9
0.60	1.150	53.5	8.50	6.65	27.8
0.55	1.292	56.4	10.52	8.16	28.9
0.50	1.469	59.5	12.96	9.98	30.0
0.45	1.696	62.9	15.99	12.19	31.2
0.39	2.067	67.4	20.71	15.60	32.7

Table A2 – Numerical simulation for alternative efficiency scores
($t^0=0.6$; $\tau=37.5\%$; $\alpha_0=\alpha_I=0.5$; $\gamma_I=10$)

Efficiency score (δ)	t^I	τ (%)	Total loss (monetary units)	Variation in tax revenues (monetary units)	Increase in the estimated magnitude of loss (%)
1.00	0.600	37.5	0.00	0.00	-
0.79	0.786	44.0	4.91	4.29	14.5
0.70	0.905	47.5	7.96	6.91	15.2
0.65	0.987	49.7	10.04	8.68	15.6
0.60	1.084	52.0	12.48	10.75	16.1
0.55	1.202	54.6	15.38	13.19	16.6
0.50	1.348	57.4	18.89	16.13	17.1
0.45	1.530	60.5	23.21	19.71	17.7
0.39	1.821	64.5	29.90	25.22	18.6

- With the Cobb-Douglas utility function, $U = l^{\alpha_0} x^{\alpha_1}$ (now $\gamma_0=\gamma_1=0$):

Table A3 – Numerical simulation for alternative efficiency scores
($t^0=0.6$; $\tau=37.5\%$; $\alpha_0=\alpha_1=0.5$)

Efficiency score (δ)	t^1	τ (%)	Total loss (monetary units)	Variation in tax revenues (monetary units)	Increase in the estimated magnitude of loss (%)
1.00	0.600	37.5	0.00	0.00	-
0.79	0.807	44.7	10.55	8.37	25.9
0.70	0.945	48.6	17.23	13.50	27.6
0.65	1.043	51.1	21.84	16.96	28.8
0.60	1.163	53.8	27.32	21.00	30.1
0.55	1.311	56.7	33.91	25.77	31.6
0.50	1.500	60.0	42.00	31.50	33.3
0.45	1.747	63.6	52.13	38.50	35.4
0.39	2.163	68.4	68.22	49.27	38.5

Table A4 – Numerical simulation for alternative efficiency scores
($t^0=0.6$; $\tau=37.5\%$; $\alpha_0=0.6$; $\alpha_1=0.4$)

Efficiency score (δ)	t^1	τ (%)	Total loss (monetary units)	Variation in tax revenues (monetary units)	Increase in the estimated magnitude of loss (%)
1.00	0.600	37.5	0.00	0.00	-
0.79	0.821	45.1	8.91	6.70	33.1
0.70	0.972	49.3	14.64	10.80	35.5
0.65	1.081	51.9	18.61	13.57	37.2
0.60	1.216	54.9	23.37	16.80	39.1
0.55	1.387	58.1	29.14	20.62	41.4
0.50	1.609	61.7	36.30	25.20	44.0
0.45	1.908	65.6	45.36	30.80	47.3
0.39	2.432	70.9	59.97	39.42	52.1

References

- Afonso, A. and St. Aubyn, M. (2005). "Non-parametric Approaches to Education and Health Efficiency in OECD Countries," *Journal of Applied Economics*, 8 (2), 227-246.
- Afonso, A. and St. Aubyn, M. (2006). "Cross-country Efficiency of Secondary Education Provision: a Semi-parametric Analysis with Non-discretionary Inputs", *Economic Modelling*, forthcoming.
- Afonso, A.; Schuknecht, L. and Tanzi, V. (2005). "Public Sector Efficiency: An International Comparison," *Public Choice*, 123 (3-4), 321-347.
- Afonso, A.; Schuknecht, L. and Tanzi, V. (2006). "Public Sector Efficiency: Evidence for New EU Member States and Emerging Markets," European Central Bank, Working Paper n° 581, January.
- Atkinson, A. and Stern, N. (1974). "Pigou, Taxation and Public Goods", *Review of Economic Studies*, 41 (1), 119-128.
- Atkinson, A. and J. Stiglitz, (1972). "The structure of indirect taxation and economic efficiency", *Journal of Public Economics*, 1 (1), 97-119.
- Atkinson, A. and Stiglitz, J. (1980). *Lectures on Public Economics*, McGraw-Hill, London.
- Auerbach, A. (1985). "The theory of excess burden and optimal taxation", in Auerbach, A and Feldstein, M (eds.), *Handbook of Public Economics*, vol. 1, 61-128.
- Diamond, P. and Mirrlees, J. (1971). "Optimal taxation and public production", *American Economic Review*, 61 (1), 8-27.
- Diamond, P. and McFadden, D. (1974). "Some Uses of the Expenditure Function in Public Finance", *Journal of Public Economics*, 3 (1), 3-21.
- Dupuit, J. (1844). "De la Mesure de l'Utilité des Travaux Publiques", *Annales des Ponts et Chaussées* 8. Translated and reprinted in K. Arrow and T. Scitovski (eds.), 1969, AEA Readings in Welfare Economics, AEA, 255-283.
- European Commission (2004). *Public Finances in EMU - 2004*. A report by the Commission services, SEC (2004) 761. Brussels.
- Geary, R. (1950-51). "A Note on 'A Constant-Utility Index of the Cost of Living'", *Review of Economic Studies*, 18 (1), 65-66.
- Hicks, J. (1936). *Value and Capital*, Oxford University Press.
- Leontief, W. (1936) "Composite commodities and the problem of index numbers", *Econometrica*, 4 (1), 39-59.

Musgrave, R. (1959). *The Theory of Public Finance*, New York: McGraw-Hill.

Pigou, A. (1947). *A Study in Public Finance*, MacMillan.

Prescott, E. (2004) “Why do Americans work so much more than Europeans?”, NBER Working Paper 10316, February.

Social and Cultural Planning Office of the Netherlands (2004). *Public Sector Performance. An International Comparison*, Social and Cultural Planning Office of the Netherlands. The Hague, September.

Stiglitz, J. and Dasgupta, P. (1971) “Differential taxation, public goods and economic efficiency”, *Review of Economic Studies*, 38 (2), 151-174.

Tanzi, V. and Schuknecht, L. (2000). *Public Spending in the 20th Century*. London: Cambridge University Press.